MEALS4NCDS STUDY PROTOCOL

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IDRC Grant/ Subvention du CRDI: 108983-001-Measuring the healthiness of Ghanaian children's food environments to prevent obesity and non-communicable diseases

Providing Measurement, Evaluation, Accountability, and Leadership Support for NCDs Prevention in Ghana: Adapting the INFORMAS Approach

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Study protocol

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Abstract

Background

Like most other countries, Ghana is experiencing an increase in obesity and nutrition-related non-communicable diseases (NR-NCDs). The need to adopt effective and comprehensive interventions/approaches to address this burden at global, regional, and national levels has been recognized. However, there is limited contextualized evidence on the implementation, and efficacy of approaches that can address NCDs in Ghana. In an earlier study, we assessed food environment priorities, and programme implementation gaps in Ghana. Building on that, this paper describes the rationale, adaptation and final protocol of a project developed to address this: The Measurement, Evaluation, Accountability, and Leadership Support for NCDs (MEALS4NCDs) project. The MEALS4NCDs project aims to measure and support public sector actions that create healthy food marketing, retail and provisioning environments for Ghanaian children, using adapted methods from the International Network for Food and Obesity/NCDs Research Monitoring and Action Support (INFORMAS). The research will facilitate understanding of the processes through which the INFORMAS approach is contextualized to a lower-middle income African context.

Methods

The protocol for this observational study draws substantially from the INFORMAS' Food Promotion and Food Provision Modules. However, to appraise the readiness of local communities to implement interventions with strong potential to improve Ghanaian children's food environments, the MEALS4NCDs protocol has innovatively integrated a local community participatory approach based on the Community Readiness Model (CRM) into the INFORMAS approaches.

Discussion

The study establishes a standardised approach to providing implementation science evidence for NCDs prevention in Ghana. It aims to demonstrate feasibility and innovative application of the INFORMAS expanded Food promotion and Food provision modules, together with the integration of the CRM in a lower-middle income setting. The protocol could be adapted for similar country settings to monitor relevant aspects of children's food environments.

Trial registration

Not applicable

Contributions To The Literature

- The need to adopt effective approaches/interventions to address non-communicable diseases (NCDs) at global, regional, and local levels has been recognized. However, there is limited contextualized evidence on the implementation, and efficacy of these approaches in many low-income settings.

- This study protocol innovatively integrates a community participatory approach into the INFORMAS approaches that have hitherto been implemented in high income countries.
- The protocol establishes a standardised approach to providing implementation science evidence for NCDs prevention in a lower-middle income setting.
- The first to describe such an approach, this paper facilitates appreciation of enhanced adaptation of the INFORMAS approach in Africa.

Background

Non-communicable diseases (NCDs) represent the leading cause of death globally; they were responsible for 70% of the world's 56 million deaths in 2015 [1]. In some African countries, NCDs are linked with over 50% of all reported adult deaths [1]; the estimate is over 40% in Ghana [2]. Africa is currently experiencing a surge in obesity [3-7] and nutrition-related NCDs (NR-NCDs) [8-11]. This rise has been partly attributed to modifiable environmental factors including diets and nutrition-related exposures. For instance, there is rapid change towards increased consumption of obesogenic, energy-dense nutrient-poor foods, [6, 12] – consistent with the so-called 'nutrition transition'. Abrahams et al [13] have reported that several African countries are at different stages of nutrition transition. Ghana is considered to be at an advanced stage given that it is experiencing rapid urbanization, and increasing overweight/obesity and diet-related NCDs [14, 15]. Overall, in Ghana, the prevalence of overweight/obesity among women of fertility age has increased from 10% in 1993 to 40% in 2014 [14, 16]. Recently, Aryeetey et al. [17] estimated the prevalence of childhood overweight and obesity in Ghana to be 17%, from a sample of 3089 children aged 9–15 years old. The work of Agyemang et al [18] as well as Ofori-Asenso et al [7] show that rates are higher in urban than rural areas in Ghana. Regarding dietary intakes, household data from the 2014 nationally representative Demographic and Health Survey (DHS) [14] indicate that Ghanaian households frequently consume foods with a high content of added sugar (e.g. sugar-sweetened non-alcoholic beverages- SSBs), and sodium (e.g. bouillon cubes (70% sodium), salted dried fish (36%), and foods processed with salt (84%)), foods high in calories, and low frequency of consumption of fruits or vegetables [14, 19]

Our recent outdoor food advertising assessment in urban Ghana identified SSBs as the most widespread food/beverage sold or advertised [20-22]. Yet, findings from Ghana's Healthy Food Environment Policy Index (Food-EPI) exercise that assessed the extent of implementation of food environment policies, showed that there is limited government action to regulate the marketing and sale of SSBs and other unhealthy foods [23]. Similar revelations have been made in Kenya [20, 24]. These studies amplify existing data poverty on food environment research and the need for action in the African region. It has long been recognized that people's food environments are a critical determinant of what they eat. Food environments are conceptualized as the collective physical, economic, policy, and socio-cultural surroundings, opportunities, and conditions that influence people's food consumption patterns [25-27]. Unhealthy food environments are not only linked to suboptimal dietary behaviour, but also adverse health outcomes, including obesity and NR-NCDs.

In response, global and regional efforts, including the development of the WHO Afro Nutrient Profiling System [28], and local efforts are begging to take hold. Globally, the International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring and Action Support (INFORMAS), was set up to monitor and benchmark food environments and policies internationally. Among others, INFORMAS seeks to increase the accountability of governments and the food industry for action to reduce diet-related NCDs and their associated inequalities [27]. Locally, the government of Ghana published national NCDs prevention policies in 2012 and 2020, which recognizes the need for interventions (including regulating the advertising of unhealthy foods and non-alcoholic beverages particularly to children) to promote healthy diets as crucial [2, 29]. However, given its traditional focus on addressing communicable diseases, and maternal and child health and undernutrition, existing initiatives by the health system to address NR-NCDs are nascent, limited in scope, scale and success [23, 30]. Existing policies have mainly been informed by evidence from high income countries (HICs) and have paid little attention to local evidence on the food environment. Thus, there is unmet need for context-appropriate evidence, which both local and regional policy makers can use to create healthy food environments and promote nutrient-rich, healthy diets that have the potential to prevent NR-NCDs, as well as other forms of malnutrition.

Aims

This paper describes the protocol of a research – the Measurement, Evaluation, Accountability, and Leadership Support for NCDs (MEALS4NCDs) prevention project that aims to measure and support public sector actions that create healthy food marketing, retail and provision environments for children in Ghana. In its entirety, the project will describe the nature and extent of unhealthy foods and non-alcoholic beverage promotion on television, in stores, and in and around schools; and the nutrition standards/guidelines that are in place to implement specific policies or programmes within public sector basic schools in Ghana. Firstly, it will evaluate the nutritional quality of foods and beverages sold or provided in basic schools. Secondly, the project will assess community stakeholders' capacity and readiness to accept and implement interventions to improve children's food environments in Ghana. Thirdly, the project's activities to build capacity on food environment research in the region, and engagement with stakeholders with potential to influence policy, are described.

Conceptual foundations and justification for the study

The study was stimulated by data from our recent efforts at benchmarking food environment policies in sub-Saharan Africa, which began in Ghana [23] as well as the established link between obesogenic food environments and NCDs. Several recent epidemiological studies and meta-analyses associate unhealthy food environments with unhealthy diets, obesity and NCD risk. These studies indicate that the consumption of ultra-processed foods (e.g. carbonated drinks, sweet/savoury packaged snacks, SSBs, chocolates), is associated with increased risk of obesity and associated NCDs [31-34]. The benchmarking of food environment policies in Ghana indicated that a great opportunity exists to effectively respond to NR-NCDs. Through interactions with local policy makers through the Food-EPI process, it was found that tackling unhealthy food promotion and improving food provision would be the most likely actions to address the problem of obesity and NCD risk factors, especially in children and adolescents [23].

Food provisioning and promotion/marketing have been shown to influence what people choose to eat (whether healthy or unhealthy). Food promotion affects food preferences and purchase behaviour, purchase requests (of children) and consumption habits[35-42]. Both food promotion and food provision reinforce social norms that unhealthy foods are acceptable and desirable [43]. with continued exposure to promotion, the brain is reprogrammed to react to cues about the food (sight, smell, thought, suggestion) - producing cravings to influence preferences, choices and ultimately, consumption or overconsumption of unhealthy foods [44, 45]. The MEALS4NCDs prevention project draws on the science of food choice, social practices of dietary intake and counter-marketing theories, to understand how food provisioning and promotion environments influence food choices, food intake, and thus, health outcomes.

The project work packages and logic model

The project will be delivered through three interlinked work packages (WPs): WP1– Food promotion, WP2- Food provision and WP3- Community Readiness. WP1 and 2 derive from existing INFORMAS Modules. WP1 Food Promotion assesses the exposure and power of promotion of unhealthy foods and non-alcoholic beverages to different population groups. WP2 Food Provision generates data to answer the question: 'What is the nutritional quality of foods and non-alcoholic beverages provided in different settings (e.g. schools, hospitals, workplaces)?' Focusing on public basic schools in Ghana, the current project will explore the socio-cultural and political context (in terms of policies, guidelines, laws, culture, social environment). It will also study the extent of programme/policy implementation, policy enforcement, compliance with existing guidelines and policies in basic schools, as well as how school pupils interact with their environment (in terms of food marketing, acquisition, provisioning, sale/retailing, and consumption). WP3- Community Readiness, not one of the INFORMAS Modules, will explore readiness of school/education stakeholders to accept and implement interventions to improve children's food environment in selected settings in Ghana (see Figure 1).

Our logic model derives from a recent realist review focused on facilitating healthy food consumption in lower-middle income African countries [46]. Thus, we hypothesize that if governments introduce policy measures that restrict marketing of unhealthy foods, their production, processing, importation, marketing will reduce–leading to decreased consumption. Similarly, if relevant food provision policies [47] are implemented in schools and early childhood education services for food service activities (canteens, food at events, promotions, vending machines etc.) to provide and promote healthy food or to expose children to higher proportion of healthy foods (e.g. fruit/vegetables) compared to unhealthy foods, this exposure will have a positive impact on dietary behaviours.

Recognizing that implementing three WPs, may not be sufficient to improve the food environment, the project seeks to examine other actions – the regulatory, legislative, and fiscal levers of food environment policy (see 'Other modules' in Figure 1). For instance, the project will explore opportunities to strengthen the capacity of food environment researchers and public sector actors to plan and implement actions in sub-Saharan Africa - in line with existing global and local calls for action [48-51].

Methods

In implementing the project, we will adopt a multi-method cross-sectional study design that applies quantitative and qualitative methods. The various methods to be deployed are described under field procedures.

Study tool development and adaptation processes

The protocol for this project was developed iteratively and collaboratively by project partners. A series of virtual engagements between the project team and leaders of the adapted INFORMAS Modules led to the development of initial drafts of the protocols. Following this, a face-to-face protocol adaptation workshop, facilitated by project co-investigators and Module Leaders was conducted in August 2019, at Aburi, Ghana. Three work teams (each team focusing on one of the work packages) were assigned the task of revising the initial draft protocol. WP1 Food provision received additional inputs from the INFORMAS School Health Group (part of the wider INFORMAS Network). The CRM component (which is not part of INFORMAS methods) adapted an existing Net-Map interview tool [52] and CRM protocol [53], building on our previous use of CRM in Ghana in deprived communities[54]. The various modifications/adaptations made to the original protocols are highlighted in Table 1. The final MEALS4NCDs protocol comprised 15 tools. Altogether, the INFORMAS protocols contributed significantly to creating a project protocol that is tailored to the Ghanaian context. Details of the field procedures are outlined below.

Field procedures

TV monitoring (Nationwide)

The following sections describe the planned implementation of the TV advertising monitoring.

Selecting TV channels, duration of monitoring and days of the week to record

Sampling of TV programming will be conducted in three stages; **1.** Selection of TV channels to monitor; **2.** Duration of monitoring (Months, Days and hours to be recorded), and; **3.** Days of the week to record. Ghanaian TV services includes free-to-air (analog and digital services) and paid satellite. By the end of June 2017, there were 51 free-to-air TV channels in Ghana; all channels have some time allocated for children's programming [55]. No data are available on child TV viewing audiences in Ghana. As such, we plan to consult with experts in the Ghana media industry including media measurement service provider – GeoPoll [55] to ensure that we select the most appropriate channels. Channels that do not broadcast adverts will be excluded. Also, pay-to-air TV channels will be excluded due to low household subscription. Number of pay TV households in Ghana in 2018 was 0.6 million and is expected to increase to 0.7 million in 2023 [56]. At a minimum, the top 3 free-to-air local/national television channels – in terms of children's viewership, will be included in the data collection process.

The data collection period will cover one school term (3 months) and one-month of vacation/recess. National holidays and special events will be excluded to ensure that data represents typical broadcasting. For each advert broadcast during the sampled period, details will be collected on brand and products, channel, time shown, nature of the product (food, non-food) and food type. All programming for selected days will be recorded from 6:00 am through to 00:00 am (midnight).

In the final stage of sampling, we will adopt the composite week sampling method to identify the days of the week to be monitored. The work of Riffe et al. [57] and Laar [58] show that this sampling approach is consistent with the INFORMAS' stratified sampling design requirement of a minimum of four days in both the working week and at weekends. Thus, the content of the three TV channels will be recorded as follows: a random start date for TV Channel 1 - Sunday for week 1, Monday will be recorded for week 2; Tuesday will be recorded for week 3, Wednesday for week 4, etc. The other two TV channels will be recorded on the same days as the first to avoid any differences in advertising patterns between weekdays and weekends. In the event that a sampled day is not eligible (e.g. national holiday or special event), the next available date is included. Irrespective of start day/date, efforts will be made to ensure that a minimum number of four weekdays and four weekend days will be recorded.

Recording data

Data will be collected manually by recording live television programmes as per existing protocols [37, 59]. All programming will be recorded onto external hard drives. The recorded data will be coded using a coding sheet (Appendix 1).

Assessments at the sub-national levels

Sampling study districts and child-serving institutions (public sector basic schools)

A multistage sampling approach will be employed to select the study's geographic region, districts, and the main Primary Sampling Units (PSUs) – public basic schools. The first stage of the sampling process will entail purposive selection of a geographic region. Of 10 regions in total, Greater Accra, which hosts the national capital was/and remains the most urbanised and most marketed to region of Ghana, will be purposively chosen. The region is sub-divided into 16 administrative districts categorized as Metropolitan, Municipal, and Districts Assemblies (MMDAs). A representative sample of six districts will be selected using both probabilistic and non-probabilistic sampling approaches as detailed below.

To select the six administrative districts, the 16 districts will be grouped into three strata/sub-administrative units of districts, municipalities, metropolises. This administrative categorization is a marker of urbanization status and gives an idea of district-level socio-economic deprivation. Of the 16, two are Metropolises with comparable poverty headcount (the proportion of population living below the national poverty line). The most urbanized will be selected. Nine are Municipalities (three will be randomly selected

after further stratification by poverty headcount); and five are Districts (two will be selected using the same criteria as in the selection of Municipalities).

With an overall sample of 200 schools, the required number of basic schools in each of the six districts will be selected using probability proportional to size, with size of the school defined as the number of pupils in the school. Schools will be stratified by location (rural or urban); level (primary, or junior high), and sorted within each stratum based on roll size data from the Ghana Education Service. Following this, a systematic random sampling will be applied in their selection. According to the records of the Education Management Information System (EMIS) of the Ghana Education Service, the Greater Accra region had a total of 862 public primary schools and 812 public junior high schools, in 2018 [60]. Sampling 200 schools will give us 80% statistical power to compare a hypothesized outdoor unhealthy food marketing rate of 47% to the recently observed rate of 57% [21].

Mapping and assessing outdoor advertising in and around selected schools

All outdoor adverts in stipulated areas, surrounding all sampled schools will be observed and recorded manually, using camera and geo-positioning systems-enabled tablets. The stipulated area will be defined using a walkable road network distance from the entrance of the school. A walkable distance is herein defined as limited by 250m road network boundaries, within which pupils are able to purchase from food vendors during short breaks. To implement this, research staff (working in pairs) will walk and observe the area within the established perimeter, around the sampled schools, to identify and record coordinates as well as pictures of all adverts (food and non-food adverts). All captured food adverts will be coded using a predesigned coding sheet (see Appendix 2). In cases where multiple adverts are included per picture, the type of advert, the type of food as well as the brand will be the focus in the photographed image. Since adverts in outlet windows count as outdoor advertising, we will capture all such adverts associated with both mobile/ephemeral and non-mobile outlets.

Mapping food provision and food retail outlets within stipulated school zones

At the same time as the outdoor advertising assessment, we will conduct a census of all food retail outlets (a place/structure used primarily for the preparation and sale of food and non-alcoholic beverages mainly for consumption off the premises) and food provision outlets (a place/structure used for the preparation, sale and serving of ready-to-eat food to customers) within the immediate school compound - using a road network distance of 250m from the school entrance. This mapping exercise will geo-locate all kinds of outlets categorized as “Supermarket; School canteen; Shop; Kiosk; Vegetable/fruit/food stand/Table top; Local vendor; Restaurant; Chop bars; Cold stores; Open market; Bakery; Drinking bar/pub as in Green et al [61]. All such outlets may be operated as completely self-service; both self- and assisted-service or full assisted service. In addition, the name of the outlet (if available) will be recorded and a picture taken. The unique foods available will be assessed and categorized using the NOVA food classification system [62] or the INFORMAS’ core, non-core, miscellaneous approach [59]. Our experience implementing similar exercises reveal a phenomenon of shared outlets/vending spaces and the tendency for outlets to appear and disappear at certain times of the day [22]. Therefore, efforts will be made to map fixed, mobile, as well as non-mobile, yet ephemeral outlets (see Appendix 3).

Conducting in-store/supermarket assessment and post-purchase exit interview

The supermarket/in-store promotional assessment will be implemented simultaneously with administration of a short exit survey (see Appendix 5), which will be administered to eligible adults customers exiting from shopping from the identified vendor. Shoppers will be eligible if they are parents/guardians with a child(ren) aged 6-17 years and have bought at least a food/beverage product from supermarket. A consecutive sample of 10 interviews per supermarket is expected. The short survey will assess overall shopping experience in the store, what was purchased, as well as promotional activities they encountered at the supermarket. In addition, relevant questions from Green and Glanz [63] perceived nutrition environment measures survey will be fielded.

Food provision policy, programme, and practice assessment and monitoring

Per existing INFORMAS protocols, the exercise will aim to, first, describe the nutrition standards or guidelines that are in place to implement specific policies or programmes within public basic schools in Ghana. Second, it will evaluate the nutritional quality of the foods and beverages sold by vendors (e.g. in school cafeterias, and canteens) or provided (e.g. foods provided by school feeding programmes) in these settings. In addition, the study will explore key considerations in making decisions around what foods are provided in such settings by engaging relevant stakeholders. We will adopt L'Abbe et al [64] two-component framework.

Briefly, Component I will involve compilation, description, and evaluation of any existing nutrition policies/programmes using the expanded INFORMAS step-wise approach. This component will involve three key steps:

Step 1 will identify food provision policies and programmes through a literature search and stakeholder interviews. The initial policy/programme identification will rely on our recent Food-EPI exercise [23], complemented with interviews with relevant stakeholders - using Appendix 6.

Step 2 will describe the characteristics of the food provision policies and programmes identified in step 1. The core characteristics to be identified will include the jurisdiction of the policy/programme; the availability of guidelines for the policy/programme; geographical coverage of the policy/programme; the school sector coverage of the policy/programme; the type of nutrition standards/guidelines associated with the policies/programmes. This will be implemented using a checklist of ideal characteristics of a school feeding policy/programme (see L'Abbe et al 2013).

Step 3 is dedicated to unpacking details of standards/guidelines applied to foods/beverages that are provided and/or sold in the identified policies/programmes and described in steps 1 and 2. For instance, step 3 will determine the basis of any applied standard (i.e. whether the standard is applied per serving or per 100g of food). With the help of a policy rating tool (see Appendix 7), we will describe existing

policies/programmes, their associated standards/guidelines, and evaluate them against ideal benchmarks for school food policies/programmes.

Component II entails monitoring implementation of food provision policies and programmes and will involve three key steps as detailed in L'Abbe et al 2013. It will be implemented using three separate study tools (see Appendices 8, 9, 10, 11). The purpose of this component is to evaluate the nutritional quality of the foods/beverages sold or provided to children in these settings relative to the nutritional standards/guidelines in any identified nutrition policy/programme. As many schools in Ghana run a system that includes both foods sold on the school compound and food provided by school canteens/commercial food service canteens, we propose to conduct our evaluation of foods sold separately from foods provided to children. Nutritional quality here refers to compliance with nutritional standards/guidelines applied in the rated 'strong' policies/programmes.

We anticipate that in many of the schools, nutritional quality assessment will not be conducted as part of the monitoring of the school food/nutrition programme, as such we will conduct interviews with school heads, administrators, and/or food service providers such as head teachers, caterers, cooks and food service vendors. Second, in the event that there are no nutrition standards/guidelines to guide implementation of school food/nutrition programme, we will conduct our assessment of the nutritional quality of the provided and/or sold foods relative to the standards applied in the INFORMAS' Core/Non-Core food classification [59] or the NOVA classification [62] , or locally generated classification[65].

Focus groups discussions (FGD) with school children and interviews with their caregivers

In total 18 FGDs will be conducted (three per district) with children (12– 17 years).. Each will comprise a maximum variation sample of 8-12 school children – selected with consideration given to gender, age, location, level of education (primary or junior high) and socio-economic status).. Focus groups will explore children's nutritional knowledge and perspective on what a healthy diet is, their typical eating habits (what they eat on a regular day –weekends/weekdays), changes in diet over time, awareness of school nutrition policies/programmes, their perspectives on promoting healthy food (counter marketing),views on food adverts in general, media influences on food choices, general recall of features of advertised product and brand recall (see Appendix 12). Parents/caregivers of children who participate in the FGDs will be interviewed. Interviews will cover parental appreciation of children's school food environment, TV influences on children's nutrition and health etc (Appendix 13).

Implementation of Community Readiness mapping (CRM)

CRM will be implemented to gauge the readiness of and capacity of our studied community/stakeholders, as well as barriers and facilitators to implement food environment improvement interventions, which is not included in the INFORMAS protocol. The CRM serves as a theoretical framework for understanding and improving community readiness for interventions [66]. Limited research has been conducted in African countries using the CRM. For example, it has been applied in Mali, [67] and in South Africa [68], and recently in Ghana [54]. In the current study, the CRM will aim to answer the question of how ready the community is to accept and implement interventions to improve children's food environments in the Greater Accra region

of Ghana. The assessment will focus primarily on aspects of the food environment related to food marketing and the availability of unhealthy foods in and around basic schools. Here, unhealthy children's food environments refer to: 'food environments that promote the consumption of unhealthy food items, such as processed meats; sugar and sweet spreads; cakes and sweets; sodas and sweetened beverages; savory snacks; fried foods; and condiments high in sugar or salt'. It can also include food that is not safe to eat because it is unhygienic or contaminated. 'The community' is operationally defined both over geographic space (geographic community), and according to stakeholders of interest (interest community). Geographically, the focus will be the six sub-community of districts of the Greater Accra region of Ghana. The interest community will comprise individuals/key informants from both within and outside of the geographic community, adjudged to wield influence and/or to play a leadership role in promoting healthy food environments. It is expected that the selected key informants will be able to provide in-depth viewpoints on existing actions to improve children's food environments and discuss their barriers and facilitators.

Individual CRM informants will be selected purposively to represent a wide range of sectors/programmes (regulatory authorities, schools, commerce, health (e.g. MoH, GHS, etc), religious institutions, school feeding programme, children/youth clubs, urban planners etc.) as well as policy areas in question – TV marketing, outdoor marketing, food provision etc. The actual list will be compiled with inputs from the study team and local people and interviewed using Appendix 14. To ensure that a maximum variation sample of key informants participate in the exercise, the CRM exercise will begin with a stakeholder mapping using the IFPRI Net-Map methodology [69]. Two to three key informants will be identified per sector. We will be measuring the overall readiness of the community. At a minimum, 6-12 interviews will be conducted (actual number will be determined following the Net-Mapping process). By adapting an existing Net-Map interview tool [52] (see Appendix 15), participants will be asked to indicate, 'Who are the stakeholders that influence children/ food environment and their dietary behaviour, at the National level?' This question will then be followed by another question on 'how do the identified actors interact with each other?'. The list that will be generated will be placed on a large sheet of drawing paper and with the help of participants, links will be drawn using the markers. Appropriate map generation tools (including large drawing paper, differently coloured markers, etc.) for drawing the map will be provided for the process. Once the links have been established, a determination of their relative influence in the food environment will be made by asking, 'how influential each actor is in promoting school food environment'.

Figure 2. Overall sampling schema (about here)

Quality assurance

Data quality assurance measures will be instituted pre – during, - post data collection – including identification of qualified field staff, rigorous training of field staff and pretesting of study tools.

For instance, during the pre-test, two principal researchers and all research assistants would code an identical area around one site independently. Their respective coding would then be compared and inter-rater reliability (IRR) computed using the formula:

$$\text{IRR} = \frac{\text{Number of agreements}}{\text{Number of agreements + number of disagreements}} \times 100$$

The INFORMAS protocols we have adapted recommend a minimum of 80% inter-coder reliability. In the event that this minimum level is not achieved, the coding discrepancies would be discussed, and further training would be given to research assistants, if required.

Similarly, for TV monitoring data, the raw data (recorded videos) will be coded by trained members of the team with the help of the study-specific coding sheet, as per the INFORMAS protocol [59] Inter-coder reliability will be computed as follows: A random sample of 10% of all coded images will be selected and coded by an independent researcher. Individual scores for each attribute (all categorical variables) will be compared using Cohen's kappa statistic (κ).

Lessons from the pretest will inform modifications and finalization of the tools. There will be no pilot study as lessons from recently implemented studies [22, 70, 71] provide sufficient guidance on sample size calculations, community entry, and field etiquette.

Data analyses

Different approaches will be deployed to analyse data from this study. We describe below how the pooled quantitative, qualitative, policy assessment and GIS data will be analysed. In Table 2 is a summary of the various indicators that will be generated as part of this project.

Analysis of quantitative data

Advertising, publicity and sales promotion of food to children via Television, and outdoor and indoor advertising within school zones will be analyzed strictly as per INFORMAS' protocols [37]. For each school, two kinds of data will be generated: one related to the outlets observed, and the other, the foods items provided or sold. Density of outlets will be calculated per $100m^2$, to enable standardized comparisons within the 250m road network distance.

For in-store marketing assessment, we will present frequencies of all promotional strategies taking place in these outlets/stores including audiovisuals (music, loudspeakers, screens with displaying promotional characters), spatial distribution and product placement. Pictures of unique foods will be assessed and categorized using the NOVA system [62], and/or the core/non-core, food-based approach developed by INFORMAS [59]. Frequency tabulation of post-shopping exit interview data detailing items purchased, overall shopping experience in the store, whether they did prior planning for the shopping at home; whether they bought any food or drink not previously contemplated; and the promotions they remember from the store. At the school level, frequencies of healthy food/beverage availability will be generated and compared by school level (primary or junior high school), district (district, municipality, metro). Ratios of healthy food outlets to total food outlets will be calculated for each provision outlet based on the total counts of each. Further, bivariate and multivariable analyses will be performed using appropriate approaches.

Analysis of GIS data

ArcGIS desktop software will be used to analyse spatial data and generate maps. Availability of various categories of products/adverts will be compared cartographically. Thus, the total number of food outlets and adverts within a 250m and 100m distance around rounds in each school will be mapped. The maps will be produced to help understand how the food environment varies spatially in our study locations. Also, to be mapped for each district and for pooled data, will be the descriptive data of frequency of food/beverage adverts, size of food advert, setting of adverts, type of advert, product type, and location of adverts or food provided/sold within the schools. Geographically weighted regression (GWR) technique will be used to model the local relationships between the predictor factors (e.g. rurality/urbanity, demographic factors; physical environment characteristics, type of school, roll size (number of student in the school), district type, poverty incidence etc.) and the outcomes of interest - intensity of outlets/adverts within 500m radius.

Analysis of qualitative data

Audio recordings of FGDs, the KIIs, as well as the IDIs will be transcribed verbatim. Transcriptions will be augmented with the researchers' field notes. The data resulting from the transcriptions will be evaluated and coded using the constant comparative method of theme generation. Qualitative software (e.g. Nvivo SQ) will be used to assist with data storage and management, including development of data files, codes, codebooks, themes, and categories. The CRM-specific transcripts will be scored by two independent scorers within the research team using 9 anchored rating statements for each dimension [72]. Data reporting will be undertaken according to the consolidated criteria for reporting qualitative research (COREQ) [73]. To maintain confidentiality, all names will be reported as pseudonyms and identifying details removed.

Data from the Net-map (including the photographs, notes, and transcripts), on the list of actors (using actor identification codes), links between actors, and relative influence will be entered into Microsoft Excel (as two separate sheets: 1. list of individual actors, and 2. list of links connecting all actors). Actor identification codes and actor categories (the broad sectors that actors belong to) will be recoded for consistency across link list and actor list. The two excel sheets will be imported into Gephi, a social network analysis software. All analyses (statistics, filtering, network image generation and visualization) and image capturing will be conducted in the overview and preview features of Gephi. Overall, and link-specific network statistics (weighted average degrees, network diameter, graph density, modularity and connectedness components) will be computed to determine network characteristics. The network visualization images will be weighted by actor nodes using relative influence. The Yifan Hu algorithm will be used to visualize network images.

Overall, data reporting will be undertaken according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies[73].

Stakeholder validation, dissemination, and knowledge translation

The results from this study will be shared during a validation workshop to open to all the MEALS4NCDs stakeholders. We will adopt the 'constructive confrontation design'[74]. It is envisaged that the process will lead to an enhanced collaborative conversation on our initial findings, critique of, and possible re-interpretation of the results. Also, draft policy briefs will be tabled for inputs during the validation workshop. We believe that the views of multiple stakeholders, will strengthen the policy briefs.

Our proposed strategies for dissemination include standard dissemination activities such as publishing peer-reviewed manuscripts (anticipate n=10 in reputable open-access journals) and presenting at local or global scientific conferences (n=6). We will also create an open-access project website, generate and disseminate project reports, produce policy briefs, conduct consultative meetings/dissemination workshops. Additional efforts to disseminate study data more widely and to support its ultimate application may entail packaging of the research findings into user-friendly formats e.g. press releases, research briefs, guided by our research findings. We will also run "building project findings into policy and practice consultative meetings" (n=4). This will entail several consultative meetings with diverse, but relevant stakeholders including government ministries, departments, international organizations including the WHO, FAO, UNICEF, as well as civil society. Among others, these meetings will deliberate on the strategies for feeding the project's findings into policies, practice, and scale up. We will produce policy briefs (n = 2 covering food promotion and provision) to facilitate dialogue with these stakeholders.

Discussion

We have described the rationale and protocol of the MEALS4NCDs project, which aims to measure and support public sector actions that create healthy food marketing, retail, and provisioning environments for Ghanaian children. The study builds on our recent efforts at introducing the INFORMAS approaches to Africa [23]. The first to describe an innovative deployment of multiple INFORMAS protocols in sub-Saharan Africa, this paper will facilitate the appreciation of the processes through which INFORMAS approaches are actualized in LMICs in Africa.

The overall hypothesis of the MEALS4NCDs project is that providing measurement, evaluation, accountability, and leadership support to governments and other stakeholders will facilitate the introduction of comprehensive and strong policies measures [47] that serve to regulate promotion of unhealthy foods or implementation of clear, consistent food environment policies in schools and other child-serving settings. By engaging stakeholders, and generating evidence that reiterates, illustrates and confirms the association between implementation of policies and improvement of the food environment, citizens, national policy makers, government officials, civil society, and industry stakeholders may find utility to the data and act in partnership.

A measure of the project's longer-term success would be the incorporation into national policy and practice, recommended interventions, and priority actions. Locally, the project's ultimate goal is the establishment and institutionalization of food environment monitoring system into the Ghana public health delivery systems in ways that regularly gathers and disseminates information to key actors (policy makers, government, programme implementers, civil society, private sector, community) for action. Regionally, we

will leverage additional funding to facilitate seamless implementation and contextualisation of other INFORMAS Modules, such as the Food Composition, Food Prices and Food Labelling. In this regard, although challenges in leveraging the needed resources is a potential limitation, the planned capacity building initiatives during this phase of the project may sustain the project vision well beyond the life of the current funding. The capacity building initiatives embedded in the project, e.g. the formation of Africa Food Environment Research Network (FERN) will instigate interest and mobilize the critical mass of experts to support this regional scaling up efforts. Globally, the project is specifically tailored to addressing International Development Research Centre's (IDRC, Canada) goal of improving food environment and therefore health, but also contributing to the ambitions of other international organisations e.g. the WHO Global Action Plan 2013-2023 on NCDs, the WHO NCD Progress Monitoring of Member Countries, and the United Nations Sustainable Development Goals (SDGs). With respect to impacting current and future food environment policies, the current cross-sectional data may appear as a limitation, however, effort to have repeated surveys will generate relevant data policy-influencing data.

List Of Abbreviations

CRM Community Readiness Model

EMIS Education Management Information System

Food EPI Healthy Food Environment Policy Index

GES Ghana Education Service

GHS Ghana Health Service

GSFP Ghana School Feeding Programme

HIC High Income Country

IDIs Qualitative in-depth interviews

IDRC The International Development Research Centre

INFORMAS International Network for Food and Obesity/non-communicable diseases Research Monitoring and Action Support

IRB Institutional Review Board

JHS Junior High School

LMICs Low and Middle Income Countries

MEALS4NCDs Measurement, Evaluation, Accountability, and Leadership Support for

NCDs prevention

MOH Ministry of Health, Ghana

NCDs Non-communicable Diseases

NR-NCDs Nutrition-Related NCDs

PS Primary Schools

PSBS Public Sector Basic Schools

PSUs Primary Sampling Units

RCO Regional Coordinating Offices of the Ghana School Feeding Programme

SHS Senior High School

WHA World Health Assembly

WHO World Health Organization

WP Work Package

Declarations

Ethics approval and consent to participate

The study will be conducted in compliance with international and local ethics guidelines. We have obtained ethical approvals from relevant Institutional Review Board (IRBs) - Ethics Review of the Humanities, University of Ghana (Approval # ECH 152-18-19), and the Ghana Health Service Ethical Review Committee (Approval # GHS-ERC 005-06-19). All interviews will be conducted after informed consent for adults 18 or older. For interviews involving minors (respondents younger than 18 years), parents or legal guardians shall complete consent forms and the children, assent forms.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable. No datasets were generated or analysed during the current study. All relevant resources related to this protocol including study tools will be made available via the project's open-access website - https://www.meals4ncds.org/en/

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AL, MH, RA, CA, FZ, MEL, KM, DL, GA, DS, SV secured funding.

AL, MH, RA, AT, CA, FZ, MEL, KM, DL, GA, DS, SV, ML, BK, RP contributed to research design

AL, WQ, AT, GA, MEL will be responsible for data collection

AL, SV, RA, GA will perform statistical analysis

AL drafted the manuscript

All authors provided critical inputs to the initial draft

All authors read and approved the final manuscript.

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Tables

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Table 2. Study outcome indicators by tool

Data collection instrument	Study outcomes/indicators
Appendix 1:TV monitoring advert coding sheet	· Mean rate or frequency of advertisements per channel per hour · Mean rate or frequency of food vs non-food advertisements per channel per hour · Mean rate or frequency of unhealthy vs healthy food ads (core vs noncore) advertisements per channel per hour · Mean rate or frequency of unhealthy (non-core) food groups · Mean rate of (healthy vs unhealthy / core vs noncore) food advertisements per channel per hour with promotional persuasive promotional techniques per unit · Ratio of healthy to unhealthy advertisements · Number of healthy vs unhealthy advertisements · Proportion of food advertisements by major food categories · Mean rate of promotional characters food vs non-food per channel per hour · Mean rate of promotional characters (food vs non-food; unhealthy vs healthy food) · Mean rate of premiums (food vs non-food; unhealthy vs healthy food) · Proportion of food advertisements by major food categories.
Appendix 2 Outdoor advertising assessment tool	· Rate of total food and non-core (and/or unhealthy) food advertisements per $100m^2$ · Rate of total food and non-core (and/or unhealthy) food advertising by size of advertisement per $100m^2$ · Rates of advertising per $100m^2$ in high and low density population areas · Mean rate of (healthy vs unhealthy / core vs noncore) food advertisements with promotional persuasive promotional techniques · Mean rate of (healthy vs unhealthy / core vs noncore) food advertisements with premium offers · Proportion of food advertisements by major food categories
Appendix 3 Tool for mapping food provision and retail outlets	· Geo-location of all food outlets within the immediate school compound and within road network buffers of 250m from the main entrance of all selected schools. · Census of all food provision and food retail outlets within the immediate school compound and within road network buffers of 250m

	from the main entrance of all selected schools.
Appendix 4 In-store marketing assessment tool	· In-store marketing/promotional strategies taking place in Supermarkets · Total healthy food shelf space covered · Total unhealthy food shelf space covered · Relative availability (cumulative shelf space covered) of healthy versus unhealthy foods · Total healthy food varieties recorded · Total unhealthy food varieties recorded · Ratio of total availability (variety) of healthy foods versus total availability of unhealthy foods in-store. · Ratios of availability of a selection of healthy food groups versus availability of a selection of unhealthy food groups in-store
Appendix 5 Exit interview or post-purchase survey	· Overall consumers' instore shopping experience
Appendix 6 Tool for identifying food provisioning policies and programmes	· Identify existing nutrition policies/programmes · Describe the characteristics of any identified nutrition policies/programmes
Appendix 7 Policy rating tool	· Obtain an objective assessment of whether or not food provision meet set existing policies/programmes standards/guidelines. · Evaluate existing nutrition policies/programmes against ideal benchmarks for school food policies/programmes.
Appendices 8 IDI guide for school heads and administrators	
Appendices 9 IDI guide for caterers	
Appendix 10 M & E review tool	
Appendix 11 Onsite observations and compliance assessment tool	
Appendix 12 Qualitative focus group discussion guide	· Children's nutrition knowledge and perspective on what is a healthy diet. · Children's typical eating habits. · Children's awareness of school nutrition policies/programmes, and satisfaction with school food provided and/or sold.

	· Children's perspectives on promoting healthy food (counter marketing), Children's views on food adverts and it influences on food choices.
Appendix 13 Qualitative KII guide for parents	Parents' appreciation of their children's school food environment, TV influences on their children nutrition and health
Appendix 14 CRM Key Informant tool	· Community readiness to accept and implement interventions to improve food environment in the Greater Accra region of Ghana. · Community leaders in-depth viewpoints on existing actions and how to improve children's food environments · Barriers and facilitators in improving children's food environments
Appendix 15 Net-Mapping tool	· Map of key actors closely engaged with or have influence in nutrition, health, and food environment (particularly for children) in Ghana. · Identified actors interact with each other